CEHNC-OE-CX (200-1c) 18 March 1997

MEMORANDUM FOR Ordnance and Explosives (OE) Team

SUBJECT: Ordnance Detection Sweep Efficiencies Guidance for Use in Ordnance and Explosives Cost Effectiveness Tool (OECERT) CX Guidance Document Number 97-01

1. The default ordnance detection efficiencies used in the OECERT were selected based upon detection methods available at the time OECERT was developed. Recent detection methods have better detection efficiencies and the default values in OECERT must be changed in order for OECERT to give realistic answers.

2. Guidance for changing the default ordnance detection efficiencies used in OECERT for use with improved detection methods is now available. The sweep efficiency values to be replaced in OECERT shall be in accordance with the procedure titled AA Method for Estimating UXO Sweep Efficiency With Depth@ (Enclosure).

3. This guidance is of a continuing nature and will remain in effect until cancelled or superseded.

4. Please contact Mr. James Manthey, OE Center of Expertise (CX) - Response Policy and Technology Team, at 205-895-1588, for more information.

Encl

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A Method for Estimating UXO Sweep Efficiency With Depth

A meaningful site risk assessment requires an estimate of UXO density as a function of depth. The quantitative evaluation of response alternatives involving removal activities requires an estimate of the effectiveness of a proposed removal activity at reducing that density, again with respect to depth. The current version of OECERT uses sweep efficiencies expressed as a percentage of UXO removed. These efficiencies are applied to UXO densities at the surface and in six discrete depth bands. The bands are 0-1 foot, 1-2 feet, 2-4 feet, 4-6 feet, 6-8 feet and 8-10 feet. Unfortunately, most data on the effectiveness of various UXO detection technologies describe only the overall effectiveness for the entire depth range used in the particular test. This effectiveness is usually expressed as a probability of detection, P_d.

The method described here can be used to estimate reasonable sweep efficiencies for these depth bands, based on a single overall P_d and a few assumptions about the nature of sweep efficiency as a function of depth. The value for P_d can be taken from any demonstration or prove out where the site conditions, UXO, technology, system employment and data analysis process are reasonably similar to those anticipated for the removal action.

The assumptions used here are:

1. The sum of sweep efficiencies by depth for all depth bands will be the overall sweep efficiency, P_d.
2. Sweep efficiency falls off smoothly with depth, first at an increasing rate, and then decreasing asymptotically to zero at a large depth.
3. Surface sweep efficiency will be 100%.
4. The sweep efficiency at 10 feet is a small, fixed value, r, related to the overall sweep efficiency.

This estimation procedure is based on a relationship between efficiency and depth of the form

$$e = f(d)$$

where e is the sweep efficiency and d is the depth. The efficiency in any depth band from x to y feet is then given by

$$e' = \int f(d)\partial d$$

evaluated between x and y. Furthermore, from the assumptions above, $e = f(0) = 100\%$, and e' evaluated from 0 to ∞ must be P_d.

To satisfy assumptions 2 and 3, above, we will take for f(d) an exponential equation of the form

$$e = A \exp (d \exp B)$$

where A and B are parameters that satisfy the boundary conditions given by assumptions 1 and 4. Assumption 3 is automatically satisfied for all A and B, since $e = 1$ for $d = 0$. Assumption 2 will be satisfied for a family of careful choices of A and B. Assumptions 1 and 4 are sufficient for a unique solution if r is defined. No data exist to fix r from a performance perspective. However, r can be fixed from a requirements perspective. In the current implementation of OECERT, no risk is assigned to UXO below 10 feet, since anticipated future land uses are expected to produce no exposures from UXO deeper than 10 feet. Since we are thus disinterested in UXO detection and removal below 10 feet, we can take the estimated efficiency to be small, say less than 1%.

Unique solutions can now be generated for sweep efficiency as a function of depth, at any overall (average) P_d. Efficiencies for specific depth bands, such as 1-2 feet, can be generated by integration of the particular solution over the interval. Efficiencies can also be estimated by simply averaging the values of the solutions at the end points of the intervals. The latter technique has been used to produce the following table of solutions.

	Percent Sweep Efficiency						
P_d (average)	Surface	0-1 feet	1-2 feet	2-4 feet	4-6 feet	6-8 feet	8-10 feet
50	100	100	97	83	49	16	3
60	100	100	100	94	71	30	
65	100	100	100	97	81	40	7
70	100	100	100	99	89	51	10
75	100	100	100	100	95	66	14
80	100	100	100	100	98	80	22
85	100	100	100	100	100	91	33